Produce Pathogens & Practical Controls

Leah Cook
Food Inspection Supervisor

Alec Adams
FSMA Outreach & Education Specialist

Maine's FSMA Produce Team
207-764-2100

MAINE DEPARTMENT OF AGRICULTURE, CONSERVATION & FORESTRY
Quality Assurance & Regulations

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A Word About FSMA:

The **Food Safety Modernization Act** is a mandatory food safety law passed in 2011, that was the first major update to the federal food code since 1938.

The **Produce Safety Rule** is the part of it that applies to produce farms. It's based on **science like this**, and establishes minimum standards on farms to keep people safe.

Not every farm is subject to it, but every farm can use the practices laid out to protect our most vulnerable eaters.

Our team does both the inspections and education for produce safety and we'll answer questions any time.

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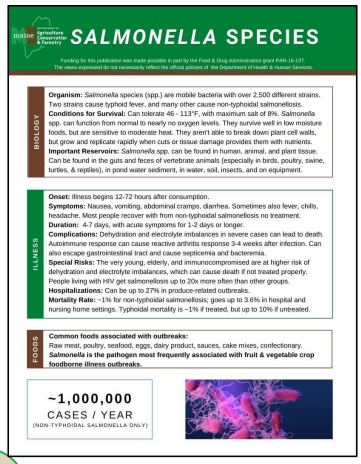
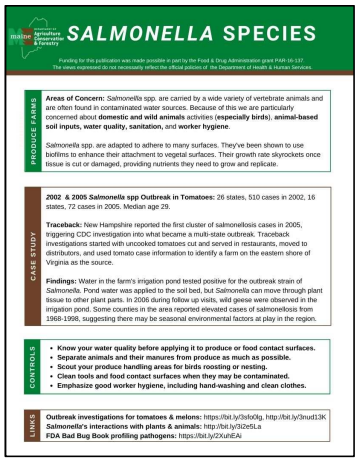
Pathogen Profiles





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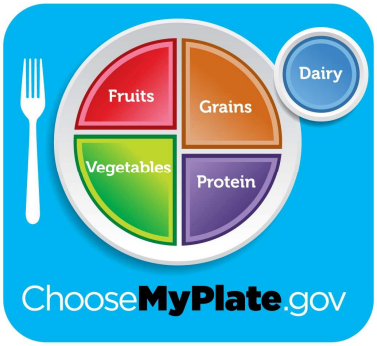
Food Safety on Produce Farms

Americans are eating more produce than ever. As consumption of fruits and vegetables rises, so do cases of foodborne illness associated with produce.

The CDC estimates **48 million** people get sick from foodborne illness each year, **148,000** are hospitalized, and **3,000** die.

Microbial hazards are the leading cause of foodborne illnesses associated with produce.



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Who Gets Sick?

A little dirt may be good for many of us, but it can really hurt our most vulnerable eaters, including:

- **Children**.
- **Elderly** people.
- **Pregnant** folks.
- People with **compromised immune systems**.

Keep these people in mind as we talk about pathogen risks on our produce farms.

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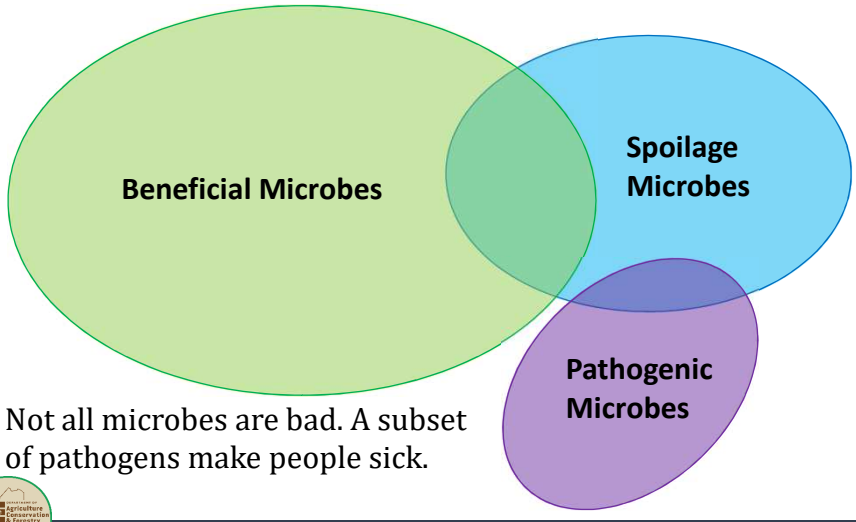
Understanding Microbes



Not all microbes are bad. A subset of pathogens make people sick.

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Key Terms

Pathogen: Any bacterium, virus, parasite, or other micro-organism that can cause illness.

Reservoir: Any animal, plant, soil, or substance where a pathogen normally lives and multiplies.

Vector: Anything that carries an infectious pathogen to or into another organism.

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Key Terms

Bacteria: A type of single-celled organism that have cell walls, but lack organelles or a nucleus.

Flagella: A slender threadlike structure that bacteria and other microbes use to swim.

Spore-forming: A type of bacteria that makes spores (a sturdy reproductive unit that can grow a new individual without other inputs).

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Key Terms

Onset: The first time symptoms become noticeable.

Duration: The length of time the illness lasts.

-osis: An infection caused by the pathogen name it follows.

Septicemia: Blood poisoning.

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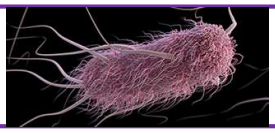
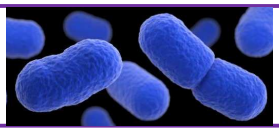
The Big 3 Produce Pathogens

1. ***Salmonella* species (spp.)**
   ~1 million cases / year

2. ***Escherichia coli* O157:H7**
   ~63,000 cases / year



3. ***Listeria monocytogenes***
   ~1,600 cases / year



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The Big 3 Produce Pathogens

1. *Salmonella* species (spp.)

~1 million cases / year
of common salmonellosis.

~27% of patients will be hospitalized
in produce-related outbreaks.

~1% of patients will die.
This increases to **3.6%** in **hospital/nursing home settings.**

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Salmonella species (spp.)

Biology:
- *Salmonella* species (spp.) are a group of mobile bacteria that move using flagella.
- There are over 2,500 different strains.
- 2 strains cause typhoid fever.
- Many others cause non-typhoidal salmonellosis (infections).

Conditions for Survival:
- Function fine at normal oxygen levels and at nearly no oxygen levels.
- Can tolerate temperatures from 46° - 113 °F.
- Survive well in low moisture, but are sensitive to moderate heat.
- Adhere to things well, and grow rapidly once produce is cut or damaged.
- Can move to different parts of the plants once it has an opening.

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Salmonella species (spp.)

Important Reservoirs:

- Gut & feces of vertebrate animals, especially birds, swine, turtles, & reptiles.
- Also found in pond water sediment, soil, water, on insects, and on equipment.

Common Foods Associated With Outbreaks:

- Raw meat.
- Poultry.
- Seafood.
- Eggs and dairy.
- Raw fruits and vegetables.

***Salmonella* is the pathogen most frequently associated with foodborne illness outbreaks for fruits and vegetables.**

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Salmonella species (spp.)

Common Symptoms:

- Nausea, vomiting, abdominal cramps, diarrhea.
- Sometimes fever, chills, headache.
- Usually resolves with no treatment.

Onset:

- 12-72 hours after consumption.

Duration:

- 4-7 days, usually with 1-2 days of acute symptoms.

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Salmonella species (spp.)

Complications:

- Dehydration and electrolyte imbalance in severe cases can lead to death.
- Autoimmune response can cause reactive arthritis response 3-4 weeks after infection.
- Can escape gastrointestinal tract and cause septicemia (blood poisoning) and bacteremia (tissue, organ, & joint poisoning).

Special Risks:

- The very **young**, the **elderly**, and the **immunocompromised** are at higher risk of dehydration & electrolyte imbalances.
- **People living with HIV** get salmonellosis up to 20x more than other groups, and are more likely to have repeat episodes.

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Salmonella species (spp.)

Areas of Concern on Produce Farms:

- **Animal activity**, both domestic and wild.
- **Manures,** animal **feces**, & **animal-based soil amendments**.
- **Worker hygiene**, especially after handling animals (including pet turtles) or animal byproducts/manures.
- **Farm water sources**, including water used for irrigation, sprays, washing produce or food contact surfaces, or for washing hands.
- **Sanitation practices** to clean food contact surfaces.

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Salmonella species (spp.)

Case Study:

2002 & 2005 Outbreaks of *Salmonella* spp. with Tomatoes:

- **510 illnesses** across **26 states** in 2002
- **72 illnesses** across **16 states** in 2005.
- **Median age** of patients was **29 years old** in 2005.

Traceback:

- NH reported first cluster of cases, triggering CDC investigation.
- ID-ed cut tomatoes served in restaurants as implicated food item.
- Followed the chain from restaurant to distributors to identify a farm on the eastern shore of Virginia as the source.

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Salmonella species (spp.)

Findings:

- Water in the farm's irrigation pond tested positive for the outbreak strain.
- They had used it to water the soil beds, not directly on the tomatoes.
- *Salmonella* can move through plant tissue to other plant parts.
- During follow up inspections in 2006, flocks of wild geese were observed in the farm pond.
- Some counties in the area have been reporting seasonally elevated numbers of salmonellosis since 1968.
- **There may be a seasonal/environmental water quality issue in the growing region.**

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Salmonella species (spp.)

What You Can Do On Your Farm:

- **Watch for animal activity** in your produce areas.
- **Pay attention to bird activity on your farm.** (Where do they nest or swim?)
- **Separate animals** and their byproducts **from your produce areas** as much as possible.
- **Know your water quality** before applying it to produce or food contact surfaces.
- **Clean tools and food contact surfaces** when they might be contaminated.
- **Emphasize hand-washing and clean clothes** with your workers.

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The Big 3 Produce Pathogens

2. Escherichia coli O157:H7

~63,000 cases / year
of from *E. coli* O157:H7 alone.

~46% of patients will be hospitalized
in produce-related outbreaks.

~10% of patients develop hemolytic uremic syndrome.
Average mortality is **3-5%**. Can be **~50% in elderly patients with HUS.**

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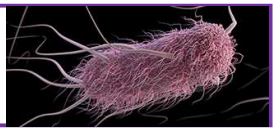
Escherichia coli O157:H7



Biology:

- *Escherichia coli* (*E.* coli) are non-spore-forming bacteria that move using flagella.
- Generic *E. coli* is so common in animal feces that it's used to indicate water quality. There are over 700 different strains.
- Many groups of *E. coli* cause traveler's diarrhea, infantile diarrhea, and bacillary dysentery.
- *E. coli* O157:H7 is the strain that most commonly causes foodborne illness.

Conditions for Survival:

- Function fine at normal oxygen levels and at nearly no oxygen levels.
- Can tolerate temperatures from 45° - 113 °F.
- Thrives in warm, damp, dark environments.

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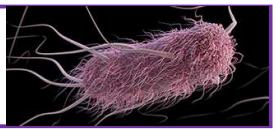
Escherichia coli O157:H7



Important Reservoirs:

- Gut & feces of animals, especially in ruminants (cattle, deer, goats, sheep).
- Human are also common carriers.
- Can persist in dust, soil, sediment, and water for weeks and months.

Common Foods Associated With Outbreaks:

- Ground beef.
- Apple cider & unpasteurized apple juice.
- Raw milk & soft cheeses.
- Water.
- Raw vegetables, especially lettuce, leafy greens, & sprouts.

***E. Coli* O157:H7 is the second leading cause of fresh produce-related illness outbreaks.**

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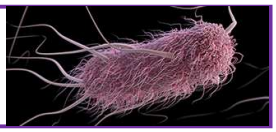
Escherichia coli O157:H7



Common Symptoms:
- Abdominal pain, diarrhea that starts out watery and often becomes bloody, vomiting, and fever.
- Antibiotics are usually not advised because they can lead to complications.

Onset:
- 3-4 days after consumption; can be up to 9 days after consumption.

Duration:
- ~8 days in typical cases.

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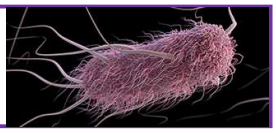
Escherichia coli O157:H7



Complications:
- Diarrhea & vomiting can lead to severe and sometimes fatal dehydration.
- Extreme and grossly bloody diarrhea (called hemmoraghic colitis), as occurring as often as every 15-30 minutes.
- 10% of patients develop hemolytic uremic syndrome (HUS), which includes anemia, blood clotting problems, and acute kidney failure.
- Some HUS patients end up needing kidney transplants.

Special Risks:
- **Children**, the **elderly**, and the **immunocompromised** are at greater risk of developing serious infections.
- Death rates for **elderly** patients with HUS can be as high as 50%.

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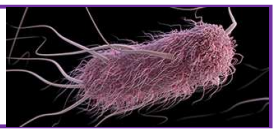
Escherichia coli O157:H7



Areas of Concern on Produce Farms:

- **Movements of cattle** and other ruminants (deer, goats, sheep).
- **Upstream/adjacent land use**.
- **Protection of farm water sources**, from both surface drainage and subsurface leaching.
- **Quality of water** and **methods of use** for produce irrigation, spraying, and sanitation of produce and food contact surfaces.
- **Manure storage** on-farm.
- **Worker hygiene**, including hand-washing and cleanliness.

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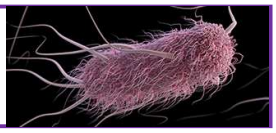
Escherichia coli O157:H7



Case Study:

April 2018 Outbreak of E. coli O157:H7 in Romaine Lettuce:

- **210 illnesses** across **36 states**.
- **96 hospitalizations, 27 cases of HUS, 5 deaths.**
- **Median age** of patients was **28 years old.**

Traceback:

- Multi-state outbreak triggered CDC & FDA investigation.
- Contaminated Romaine was traced to Yuma growing region straddling the border of Arizona & California.
- 36 fields on 23 different farms were identified as the suppliers of the contaminated lettuce.

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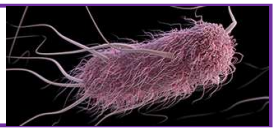
Escherichia coli O157:H7



Findings:

- A 3.5 mile stretch of irrigation canal used by many of the area's farmers tested positive for *E. coli* O157:H7.
- Several large cattle feeding operations adjacent to the irrigation canal were identified as the likely upstream source of the outbreak strain.
- Many farmers in the region had used water from the canal to dilute pesticides prior to application.
- A late frost led to some freezing injury on the lettuce, creating tissue damage.
- Pathogenic *E. coli* preferentially colonizes damaged edges of plant tissue.

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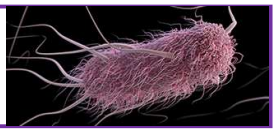
Escherichia coli O157:H7



What You Can Do On Your Farm:

- **Separate animals & their manures** from produce and water sources.
- **Know your water quality** before using it for sprays, irrigating, or cleaning.
- **Look upstream** and consider **adjacent land use** that might drain into your fields or water sources.
- **Check the condition of your well** and/or **septic system.**
- **Don't harvest** produce that may have been contaminated by animal feces.
- **Think about your boots, wheels**, and **livestock traffic patterns**.
- **Emphasize hand-washing and clean clothes** with your workers.

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The Big 3 Produce Pathogens

3. *Listeria monocytogenes*

~1,600 cases / year
of listeriosis.

~94 - 99% of patients will be hospitalized
in produce-related outbreaks.

~40% of patients can die
during produce-related outbreaks.

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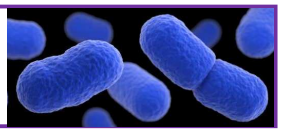
Listeria monocytogenes



Biology:
- *Listeria monocytogenes* is a non-spore-forming bacteria that moves using flagella.
- There are other species of *Listeria*, but only 1 other species is considered pathogenic, mostly to ruminants (cattle, deer, goats, sheep).

Conditions for Survival:
- Function fine at normal oxygen levels and at nearly no oxygen levels.
- Can survive and grow at temperatures as low as 1° - 113 °F.
- Salt and nitrile tolerant.
- Can form biofilms on various surfaces to help it resist environmental stress.
- Outcompetes other organisms that can't grow and replicate in cool, wet conditions.

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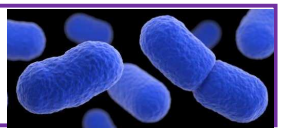
Listeria monocytogenes



Important Reservoirs:

- *L. monocytogenes* is very prevalent in the environment.
- Guts & feces of ruminants (cattle, deer, goats, sheep) are important reservoirs.
- Also found in soil, silage, decaying vegetation, & cold, wet, difficult-to-clean areas of equipment and facilities.

Common Foods Associated With Outbreaks:

- Raw dairy.
- Meat & poultry.
- Seafood.
- Cooked, ready-to-eat foods.
- Raw fruits and vegetables, incl. melons, sprouts, & cut celery.

***Listeria monocytogenes* has the highest hospitalization rate out all 31 major foodborne pathogens.**

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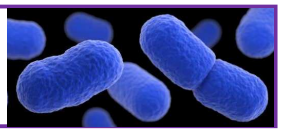
Listeria monocytogenes



Common Symptoms:

- Diarrhea, fever, fatigue in most healthy people.
- Headache, stiff neck, confusion, loss of balance, muscle aches.
- May be asymptomatic in healthy people.
- Usually treated with antibiotics.

Onset:

- 3 days – 3 weeks after ingestion.
- Can sometimes begin within hours of consumption.

Duration:

- Varies from several days to several weeks in healthy people.

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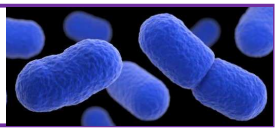
Listeria monocytogenes



Complications:

- Invasive listeriosis can cause septicemia (blood poisoning), meningitis (inflammation around brain and spinal cord), or encephalitis (inflammation of the brain).
- Intrauterine or cervical infections can cause miscarriages and stillbirth.

Special Risks:

- **Pregnant people, fetuses,** and **newborns** are at particular risk of life-threatening illness if exposed to *L. monocytogenes* during pregnancy.
- **Elderly people** and the **immunocompromised** are at higher risk of invasive listeriosis.

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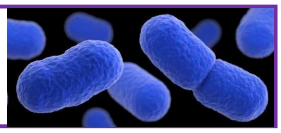
Listeria monocytogenes



Areas of Concern on Produce Farms:

- **Cooler storage areas,** including **along baseboards.**
- **Floor drains**.
- **HVAC/Cooling equipment.**
- **Condensate** from cooling equipment.
- **Difficult-to-clean areas** of **produce equipment.**
- **Equipment design** appropriate to the type of crop it's being used with.
- Areas where **standing water pools**.

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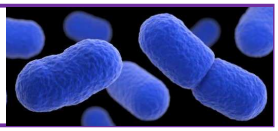
Listeria monocytogenes



Case Study:

2011 Outbreak of *Listeria monocytogenes* with Cantaloupe:

- **147 illnesses** across **28 states.**
- **145 hospitalizations, 33 deaths, 1 miscarriage.**
- **Median age** of patients was **77 years old**.

Traceback:

- Multistate outbreak triggered CDC & FDA investigation.
- Was the largest outbreak associated with *Listeria* in US history.
- Patients had leftover melon that was tested.
- Traceback went through retail stores to the broker back to a single farm in Colorado.

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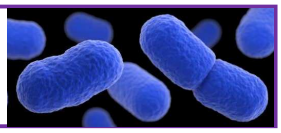
Listeria monocytogenes



Findings:

- All samples in the growing field (water, soil, animal feces, cantaloupes) were negative.
- Evaporators in the cooler weren't plumbed, creating standing water.
- Floor drains weren't easy to access to clean.
- A piece of potato equipment was being used to clean melons.
- No sanitizer was used in the spray bar.
- Multiple samples in the facility (floors, drains, equipment line, melons in cooler) tested positive, even after equipment was disassembled, cleaned, and sanitized.
- Facility didn't test negative until sections of equipment were removed and the line was re-cleaned.

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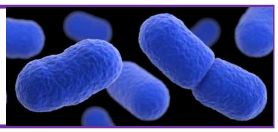
Listeria monocytogenes



What You Can Do On Your Farm:

- **Plumb evaporators** and **cooling equipment.**
- **Prevent** and **eliminate standing water**.
- Make sure your **equipment is designed to allow for proper cleaning**.
- **Clean facilities and equipment regularly**, with detergents, not just water.
- **Keep produce from touching the floor/ground** as much as possible.
- **Use a sanitizer** in your wash water for high risk produce.
- **Get the field heat out** of your produce before storing it in the cooler.

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The Big 3 Produce Pathogens

1. ***Salmonella* species (spp.)**
   ~1 million cases / year

2. ***Escherichia coli* O157:H7**
   ~63,000 cases / year

3. ***Listeria monocytogenes***
   ~1,600 cases / year

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Produce Pathogens in 1 Slide:

***Salmonella* spp.**
~1 million illnesses
~1% mortality
BIRDS & WATER

***E. Coli* O157:H7**
~63,000 illnesses
~3-4% mortality
CATTLE & WATER

Listeria monocytogenes
~1,600 illnesses
~40% mortality
COOLERS & EQUIPMENT

MAINE DEPARTMENT OF AGRICULTURE, CONSERVATION & FORESTRY www.maine.gov/dacf/qar/

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Okay - How Can I Learn More?

- Check out the **Pathogen Profiles** from this session.
- Get in touch with us to set up **a free on-farm advice session**.
- Ask us for the FSMA **Produce Safety Rule starter-pack** of info.
- Attend a **Produce Safety Alliance Grower Training** hosted by the University of Maine Cooperative Extension.

Contact us at 207-764-2100, through the Whova app, or email Leah at leah.cook@maine.gov.

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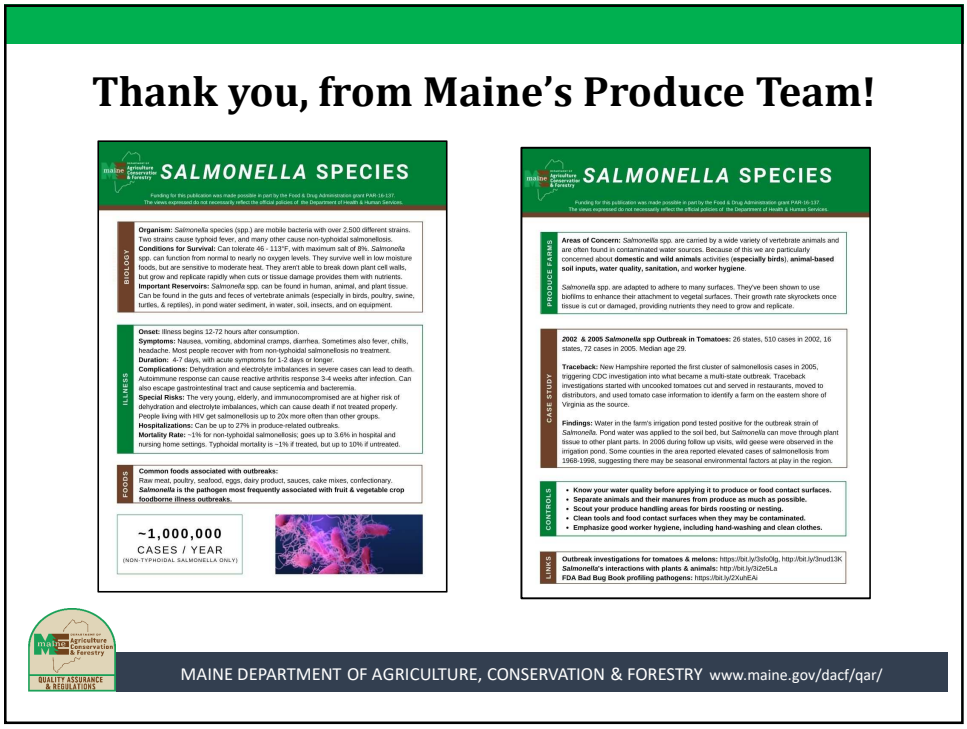

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